

CLAIMS

What is claimed is:

1. A method, comprising:

placing a multilayer work-piece having a pinhole in a capping layer to a chamber;

introducing a precursor gas into the chamber in the immediate area of the multilayer work-piece; and

directing an electron beam at the pinhole of the multilayer work-piece.

2. The method of claim 1, wherein the electron beam induces a chemical reaction with the precursor gas that causes the precursor gas to dissociate.

3. The method of claim 1, wherein the capping layer comprises silicon.

4. The method of claim 3, wherein the precursor gas comprises SiH_4 or Si_2H_6 .

5. The method of claim 1, wherein the capping layer comprises ruthenium.

6. The method of claim 5, wherein the precursor gas comprises RuF_6 , $\text{Ru}(\text{CO})_5$, or $\text{Ru}_3(\text{CO})_{12}$.

7. The method of claim 1, wherein the capping layer comprises carbon.

8. The method of claim 7, wherein the precursor gas comprises CH_4 or any other hydrocarbon.

9. The method of claim 1, wherein the multilayer work-piece is a mask blank.

10. The method of claim 1, wherein the multilayer work-piece is a multilayer blank.

11. A method, comprising:

adding a capping layer to an extreme ultraviolet (EUV) mask comprising reflective multilayer deposited on a substrate;

inspecting the capping layer for a first pinhole; and

depositing a first capping filling at the first pinhole.

12. The method of claim 11, wherein the deposition of the first capping filling is performed by directing an electron beam at the pinhole in the presence of a precursor gas.

13. The method of claim 12, wherein the capping layer comprises silicon and the precursor gas comprises SiH_4 .

14. The method of claim 12, further comprising:

etching an absorber layer and a buffer layer to form a patterned mask;

inspecting the capping layer for a second pinhole; and

depositing a second capping filling at the second pinhole.

15. The method of claim 14, further comprising:

cleaning the EUV mask surface;

inspecting the capping layer for a third pinhole; and

depositing a third capping filling at the third pinhole.

16. The method of claim 12, wherein the electron beam is generated by an electron optical system.

17. The method of claim 15, further comprising:

modulating a growth rate of the first capping filling by adjusting a voltage of the electron beam.

18. The method of claim 17, further comprising:

increasing the voltage of the electron beam to increase a spatial resolution of the first capping filling.

19. An apparatus, comprising:

a work-piece mount to secure a extreme ultraviolet (EUV) multilayer work-piece; and

an electron source to provide an electron beam at a capping layer pinhole of the multilayer work-piece, wherein the electron source is adjustable to focus and direct the electron beam at the pinhole.

20. The apparatus of claim 19, further comprising:

a gas source to generate a precursor gas, wherein the precursor gas contacts the multilayer work-piece, wherein the electron beam dissociates the precursor gas to form a filling material at the pinhole.

21. The apparatus of claim 19, wherein the electron beam has a landing voltage between 500 volts and 20,000 volts.

22. The apparatus of claim 19, wherein the work-piece mount is enclosed in a chamber.

23. The apparatus of claim 20, wherein the electron beam is scanned to deposit a film in a desired shape.

24. The apparatus of claim 20, wherein the precursor gas comprises ruthenium.

25. The apparatus of claim 20, wherein the precursor gas comprises silicon.

26. The apparatus of claim 20, wherein the precursor gas comprises carbon.

27. An extreme ultraviolet (EUV) mask blank, comprising:
- means for inspecting the EUV mask blank for defects;
 - means for localized deposition of a capping filling in the pinholes; and
 - means for heating the EUV mask blank to enhance repair quality.
28. The EUV mask blank of claim 27, further comprising:
- means for selecting a precursor gas.
29. The EUV mask blank of claim 27, further comprising:
- means for modulating spatial resolution of the capping filling.
30. The EUV mask blank of claim 27, further comprising:
- means for modulating the growth rate and purity of the capping filling.